The syntax of language

• How do we form sentences?
• Processing syntax.
• Language and the brain.

Productivity (again)

• We can combine words into new sentences
  – The brown dog ate some smelly food.
• If we know a word, we can use it in a variety of different sentences.
  – The smelly dog ate some brown food
  – How are we able to form these new sentences
• A limited set of basic units (words)
  – A set of rules for combining words (grammar)

Syntax

• The grammatical structure of a language
• Languages have a structure that determines how words are put together to form sentences
• Types of words
  – Nouns: Refer to objects, concepts and locations
  – Verbs: Refer to actions or states.
    • Verbs structure a sentence
  – Modifiers: Used to add information to nouns and verbs
  – Structural words: Prepositions, articles
    • These are closed class words
Forming sentences

- Words are combined to form sentences
- English is a word order language
  - Syntax is based (mostly) on word order
  - Most languages are case languages
    - Prefixes and/or suffixes are added to words to indicate the role they play in a sentence.

Grammatical rules

- Most grammars involve rewrite rules
  - Here are some examples
- \( S = NP + VP \)
- \( NP = (Art) + (Adj) + N \) [A big dog]
- \( VP = V + NP \) [bought a dress]
- \( VP = V \) [sang]
- \( V = V + NP + PP \) [brought his friend to the party]

Sentence Production

- When speaking, create a sentence that follows the grammatical rules
  - Person must first have a thought
  - The thought is translated into language
- Sometimes different thoughts can lead to the same sentences
Another example

• Sarah saw a man eating shark
• \([ \text{Sarah} \text{NP} \text{[saw [a man]NP} \text{[who was eating shark] VP I}_{S} \text{]} \text{I}_{S} \text{]}\)
• \([ \text{Sarah} \text{NP} \text{[saw [a man eating shark] NP] VP I}_{S} \text{]}\)
• The same sentence can be parsed into two different structures.
  – The structure influences the meaning
• The productivity of language leads to ambiguity
• We rarely notice this ambiguity (except in jokes)

How do we process sentences?

• We do not have a whole sentence in front of us to process
  – We hear one word at a time
• We hold a few words in working memory
  – We must parse a sentence as it comes in
  – As always, we use constraints
    • Our parser makes guesses about sentences

The cat sat on the mat.
Syntactic illusions

- Constraints can sometimes cause problems
  - *Garden Path Sentences*
    
    The horse raced past the barn fell.

- People do not typically produce sentences like this.

Language and the brain

- Many observations of language disruptions following brain damage.
- Language appears to be localized in the left hemisphere.
  - Some left-handed people are lateralized differently
- Types of language disruptions
  - Aphasia: Disruptions of language processing
  - Agnosia: Disruption of naming

Some important brain areas for language

- Broca’s area
- Wernicke’s area
Aphasia

- There are many types of aphasia
  - Each is characterized by particular deficits
- Two common types of aphasia
  - Broca’s aphasia
    - Grammatical problems
    - Speech is telegraphic
    - English comprehension focuses on word order
  - Wernicke’s aphasia
    - Fluent grammatical processing
    - Disruption of semantic performance
    - Speech is “word salad”

  May involve too little activation in semantic network.

  May involve too little inhibition in semantic network.

Agnosia

- People have trouble naming objects
- Can be specific to particular categories
  - Vegetables, artifacts
- Prosopagnosia
  - Specific to faces
- Not a perceptual deficit
  - People can describe the objects
  - Can draw them accurately
  - The connection between the perceptual representation and the label is damaged.

Language and intelligence

- Williams syndrome
  - Preserved language abilities
  - Severely impaired cognitive abilities
- Suggests that the ability to learn words and form sentences is not just a component of general intelligence
- Language learning
  - We learn language differently from many other things
  - Language is learned incidentally
  - Language learning is worse in adults than in children
    - For most cognitive abilities, the opposite is true.
Summary

- Syntax allows languages to be productive
- Can characterize syntax as a set of grammatical rules
- Parsing (finding the syntactic form of a sentence)
  - Must be done “on-line”
- Language and the brain
  - Aphasia
  - Agnosia